Information technology and renewable energy — Modelling, simulation, decision support and environmental assessment

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Abstract: The transition of energy systems toward a higher share of renewable energy creates complex challenges in designing, implementing, controlling and maintaining the systems. Environmental assessments of system structures and the decisions made during design, implementation and operation are usually based on complex data, models and decision procedures and therefore involve innovative applications of information and communication technologies (ICT). This special issue of Environmental Impact Assessment Review gives a broad overview of ICT-based approaches to meet the challenges of renewable energy sources. It is based on papers selected from the 27th EnviroInfo Conference held at the University of Hamburg in September 2013 under the theme "ICT and Renewable Energies" (Page et al., 2013). The papers have been expanded by the authors and submitted to this special issue. In addition, some papers submitted to this journal independent of the EnviroInfo conference were included in the special issue.

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Information Technology and Renewable Energy – Modelling, Simulation, Decision Support and Environmental Assessment

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The transition of energy systems toward a higher share of renewable energy creates complex challenges in designing, implementing, controlling and maintaining the systems. Environmental assessments of system structures and the decisions made during design, implementation and operation are usually based on complex data, models and decision procedures and therefore involve innovative applications of information and communication technologies (ICT).

This special issue of Environmental Impact Assessment Review gives a broad overview of ICT-based approaches to meet the challenges of renewable energy sources. It is based on papers selected from the 27th EnviroInfo Conference held at the University of Hamburg in September 2013 under the theme "ICT and Renewable Energies" (Page et al. 2013). The papers have been expanded by the authors and submitted to this special issue. In addition, some papers submitted to this journal independent of the EnviroInfo conference were included in the special issue.

A positive or negative environmental impact of ICT can occur at different system levels, depending on how far the causal chains of ICT applications are followed and what time horizon is assumed. According to the model we recently proposed as the LES model (Hilty and Aebischer 2015), these impacts can be categorized into life cycle impacts (L), enabling impacts (E), and structural impacts (S). Most of the papers in this special issue deal with enabling impacts.

ICT applications can support multi-criteria decision-making regarding the location of renewable power plants in the context of environmental impact assessment, as Wanderer and Herle demonstrate with a Web-based decision-support system. A similar, but more general and model-based approach is presented by Palmas and colleagues in the context of regional planning for renewable energies. The main objective is here to improve spatial efficiency.

Morelli presents Web-tools that combine model-based performance analysis of solar energy plants with the processing of near real-time satellite remote sensing data of incident solar irradiance. This approach, which starts from remotely sensed optical images, enables both the assessment of installed power plants as well as the prediction of the performance of future installations, providing a return of investment analysis.

Rose provides a method for the 3D Simulation of glare that can occur as a negative side effect of photovoltaic (PV) systems. Assessing glare and the resulting discomfort or even safety risk (e.g., in traffic) is an obvious requirement for the environmental assessment of PV systems.

The operation and maintenance (O&M) processes of offshore wind farms are extremely challenging because of the high maintenance cost and the stochastic nature of the weather conditions. Joschko and colleagues provide a model to simulate the O&M processes, including the weather conditions. This model is used to identify critical aspects of the processes and improve them in the long term.

Sonnenschein and colleagues explore the potential of decentralized control in smart grids that must cope with the fluctuating power from renewable energy sources. The focus of this work is the demand-side management based on self-organized clusters of units.

Adressing ICT as an energy consumer, Kern and colleagues ask how we can assess the impacts of software and software engineering on the carbon footprint of ICT systems. The influence of software is an essential and still underinvestigated driver of the life cycle impact of ICT products and services.

Long-term renewable energy scenarios (time horizon: 2050) are assessed for their human health impact trough the temporal change of fine particle concentrations in the last article by Gschwind and colleagues. The scenarios were computed for 45 European countries. The average fine particle concentration over Europe in a maximum renewable power scenario is shown to be reduced by 85% and the health impact by 34% compared to the baseline scenario.

We hope that this special issue will inspire the further development of ICT-based decision-support systems and environmental assessment methods for renewable energy systems.

Guest editors

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